



IECRE OPERATIONAL DOCUMENT

**IEC System for Certification to Standards relating to Equipment for use in
Renewable Energy applications (IECRE System)**

Blades testing assessment – 2016 type certification





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CONTENTS

CONTENTS	2
1 Background	3
Annex A : Assessment Checklist.....	4

1 Background

This document is intended to be used as a guide to assess the competency of test laboratories as RETL under IECRE for blade testing per IEC 61400-23.

The check list In Annex A should be filled out during the assessment. Assessors are requested to continuously improve this checklists based on experience using it.

Annex A: Assessment Checklist

Item nr	category	requirement	question	finding
General				
1		Personnel qualifications	How are people authorized for performing testing? (training, mentoring?). Is sufficient documentation available?	
2			Is authorization done for specific parts like test design, instrumentation, inspection, data validation analysis, etc.?	
3		Proficiency testing	Review proficiency testing results and discuss reason for differences. Document these and assess if these are interpretation of the standard or deviations from clear requirements	
4		Test article tampering	Is the test article under the test laboratory's (or another independent organization) control so no unknown repairs/ fixes can be made? When repairs or modification of a test article are made, how are they documented by the laboratory?	

Item nr	category	requirement	question	finding
5		Laboratory procedures and forms (Typically part of ISO 17025 QA system)	Review laboratory and test specific procedures and forms. Procedures should provide sufficient detail to ensure consistency in tasks such as installing instrumentation, maintaining calibration records, etc. When forms are used to assist in complying with log book requirements, these should be collected in a way that ensures a complete test record is available.	
<p>Have test lab identify executed tests available for assessment, select one of the tests to use in the remainder of this checklist. Document which test is being used:_____</p> <p>To provide a complete evaluation the selected test should ideally include all aspects of the minimum requirements for a full IEC-61400-23 certification test:</p> <ul style="list-style-type: none"> • Mass, center of gravity and natural frequencies • Static tests • Fatigue load tests • Post fatigue static tests 				
<p>Specific sections in the 61400-23 standard are referenced by section number at the beginning of the following requirements where applicable.</p> <p>Note: a blade test is conducted as collaboration between the designer or manufacturer of a blade and the test lab. The discussion below will use the term “customer” to refer to this outside party who is requesting and specifying the details for the structural test.</p>				

Item nr	category	requirement	question	finding
6. Documentation and procedures for the test blade				
6		6. Documentation: Test records include	Is the test article model and serial number clearly defined?	
7		<ul style="list-style-type: none"> • Unique identification • Relevant drawings and specifications 	Is documentation or data provided by the customer or other third parties clearly identified as such in any reports produced by the test lab?	
8			Are the responsibilities of the test lab and the customer clearly delineated? For example, typically the designer will often specify the fully factored target test loads including the test factors required by the IEC 61400-23 while the lab will design the test to achieve or exceed those loads.	
9		6. Repairs should also be documented. Repairs or modifications performed after the blade arrives at the test lab should be noted in the test documentation.	Are any repairs made by the manufacturer during the testing process noted in the test lab report(s)? Full documentation of repairs is responsibility of manufacturer.	
7. Blade test program and test plans				
10		Areas to be tested. Critical areas of the blade to be loaded shall be identified in the test plan.	If test design is responsibility of test lab, has customer identified critical areas of the blade to be tested?	

Item nr	category	requirement	question	finding
11		9.2 Influence of load introduction	Often the customer is responsible for assessing if reinforcement is required around a load introduction and for implementing this. Areas around load introduction points are constrained and not considered tested.	
12		Test plan(s) shall be established for all the individual tests in a blade test program. The test plans shall include: <ul style="list-style-type: none"> • Blade description • Specification of loads • Conditions of loading • Instrumentation to be applied • Inspections to be performed 	Review information included in test plans.	
13		7.3.2 Blade description <ul style="list-style-type: none"> • Geometry <ul style="list-style-type: none"> ○ Blade length ○ Chord and twist distribution ○ Pre-bend and/or sweep • Mass and CG (predicted) • Blade surface condition • Blade mounting details • Lifting and handling procedures • Maximum expected 	Typically the customer provides this information in a test specification or similar document. Test plan may reference this.	

Item nr	category	requirement	question	finding
		deflections under load <ul style="list-style-type: none"> • Profile geometry at load introduction points. 		
14		7.3.3 Loads and conditions: Test plan shall include the target loads, test loads, application methods and sequence of test to be conducted. Environmental conditions that impact the test shall also be given.		
15		7.3.4 Instrumentation position and orientation of load cells, strain gauges, deflection transducers and other sensors shall be specified in the test plan.		
16		7.3.5 Expected (predicted) test results.	The 61400-23 recommends predictions of deflections, strains, etc. be provided to assist in planning and executing a test.	
8. Load factors for testing				
17		8. Load factors for testing.	Are the partial test factors stated in test plan and report or are pre-factored load provided that are used to design the test? Ensuring that a test loads include the required test factors from section 8 is typically the responsibility of the customer.	

Item nr	category	requirement	question	finding
9. Test loading and test load evaluation				
18			Typically defining the target test loads is the responsibility of the customer. If the test lab has a role in this, than that work should be reviewed.	
19			The test lab may assist the customer in determining if their applied loading is acceptable – for example by comparing the extreme fatigue loads to be applied to the static test loads.	
Test execution requirements				
20		10.1.1 Test records	Review log book entries to assess if sufficient detail is being recorded to allow for proper time categorization, if unsure copy excerpts to discuss with other assessors.	
21			Review laboratory forms. In combination with the log book these should provide sufficient information to document the test and provide any test geometry or instrumentation details not included in the data files or log book. Forms should be completed accurately and identify the test article, person who filled it out and date.	
22		10.1.4 Root fixture and test stand requirements	Has the lab evaluated the stiffness of their test stand and either verified that the influence on tip deflection is less than 1% or accounted for the deflection of the	

Item nr	category	requirement	question	finding
			test rig in the analysis?	
23		10.1.5 Environmental condition monitoring	Meet minimum requirements of recording temperature outside, inside and on the surface of the blade. Ambient humidity may also be required for some materials.	
24		10.1.6.1 Tare loads	Are tare loads and their locations documented?	
25			Is it documented under what conditions and with what tare loads channels are offset to read zero (i.e. what is the reference condition for the measurements)?	
26		10.1.6.2 Load angle changes	Are the load angle changes during deflection taken into account? See analysis section.	
27		10.1.6.3 Induced torsion loading	Is induced torsional loading considered? Is it necessary to consider for the test in question?	
10.2 Static test				
28		10.2.1 General	Static tests should provide information demonstrating the blade supports the required loads and evaluating the deflection (stiffness) relative to the design.	
29		9.3 Static load testing	Duration of 100 % load shall exceed 10 seconds or time specified by customer based on design.	

Item nr	category	requirement	question	finding
30		10.2.2 Static test load: During static load tests, shall measure: <ul style="list-style-type: none"> • Magnitude and direction of the applied load(s) at the five load levels where strains are measured. • a time signal (actual or derived from sample rate) 	Review raw and post-processed data. Direction of applied loads may be assessed in a variety of ways. Consider if the uncertainty in the method used is reasonable.	
31		10.2.3 Strain measurement. Strain measurements shall be taken for at least five load levels distributed over the load range used in the test.	Strain gauges locations are typically specified by the customer.	
32		10.2.4 Deflection measurement: Deflections shall be measured at three or more points along the span.	Deflection measurements are typically used to verify the global stiffness and evaluate or validate the load cable angles determined for 10.2.2	
10.3 Fatigue test				
33		The following shall be recorded: <ul style="list-style-type: none"> • Cycle count • Signals used to control the blade test (applied loads, deflections, accelerations, strains) • Functionality of sensors shall be verified throughout the test. Critical sensors shall be fixed or replaced when the fail. Stiffness of the blade shall be checked 	This data should be sufficient to ensure that the required damage equivalent load is achieved. Review what the lab does when various sensor types fail. How is the data processed and reported when a sensor (e.g. a strain gauge) failed for a portion of the test?	

Item nr	category	requirement	question	finding
		and documented several times throughout the test.		
34		9.4 Fatigue load testing	Typically the customer defines the Miner summation slope factor. The test lab may be responsible for determining the total damage equivalent load applied during the test.	
35		Repairs during fatigue testing	If any repairs were performed during fatigue testing how were they documented? Had the repaired area already achieved the target damage level?	
10.4 Other blade property tests				
36		10.4.1 Blade mass and CG shall be determined.	How was the mass/cg measurement obtained? Are the uncertainty estimates reasonable for these results? Is any additional hardware noted? Are any tare loads appropriately accounted for?	
37		10.4.2 Natural frequencies. Minimum of 1 st and 2 nd flatwise and edgewise frequencies shall be measured.	Review how natural frequency measurements are conducted. Is any instrumentation attached to the blade during these measurements noted? Is it necessary to account for the influence of that equipment mass?	
Data acquisition and instrument calibration				
38			If different data acquisition systems are used is synchronization set and maintained. Is the error evaluated?	

Item nr	category	requirement	question	finding
39			Is the data under the TL's control from the moment it is generated?	
40			Is the sample rate sufficient to achieve accurate measurement results during static and fatigue testing?	
41			Is any resampling or down-sampling performed?	
42		10.1.2 Instrument Calibration	Is there evidence that all instruments were calibrated?	
43			Are all calibration factors applied correctly? How is this checked or verified? How is it corrected if an error is detected later?	
44			Were additional checks performed to assure signals were wired correctly and functioning (end-to-end checks)?	
45			If any instrument changes were performed during the test how is it assured that those changes were implemented correctly? Were those changes documented (for example, replacing a strain gauge).	
46			Were any recalibrations or post-test calibrations performed?	
47			Is the range for all channels set properly (no clipping, sufficient resolution)	
48		Data acquisition system	How is the data acquisition system (including software) validated?	

Item nr	category	requirement	question	finding
Analysis				
49		Analysis software	Custom analysis software will typically include tools for designing static and fatigue tests and post-processing tools for mass and CG, Eigenfrequency, static and fatigue tests.	
50			If custom analysis tools are used. Is the software version controlled?	
51			How is the software validated?	
52		10.1.6.2 Effects of Load angle.	Does the lab correctly evaluate the bending moment applied to the blade accounting for the large deformations and actual test setup?	
53		10.1.6.3 Induced torsional loading	Is this considered in designing tests or evaluating test results? Is it necessary for the example test under review?	
54		Fatigue test load evaluation	<p>If the fatigue test is performed by resonance excitation, review the measurement of strain sensitivities (static calibration) and calculation of the fatigue during fatigue.</p> <p>Is constant amplitude loading assumed or is damage equivalent load for the entire test calculated?</p> <p>Are the assumptions made reasonable?</p> <p>How is missing data handled?</p>	

Item nr	category	requirement	question	finding
55		<p>10.1.3 Measurement Uncertainties</p> <p>The following shall be estimated and reported:</p> <p>Uncertainties in magnitude, direction and location of the applied load, displacement and measured strain.</p>	<p>Are all device uncertainties evaluated including entire measurement chain (calibration referenced, data acquisition accuracy and precision).</p>	
56			<p>Review estimation of uncertainty for any final measure and results including:</p> <ul style="list-style-type: none"> • Applied static bending moments • Fatigue load applied or damage equivalent load. • Mass and CG • Natural frequencies <p>And any other calculated results.</p> <p>How are the inputs estimated or assessed? Are reasonable engineering approaches used? Are the inputs and method followed indicated in the reports?</p>	

Item nr	category	requirement	question	finding
11. Inspections				
57		11.1 Visual Inspection. Before test, after test and at frequent intervals during fatigue test. Inspection results shall be documented in the logbook.	In general the lab is responsible for observing and reporting any irreversible changes observed in the blade over the course of the testing. If any repairs are conducted this should be noted in the test log.	
58			Was an inspection performed when the blade arrived at the lab?	
59			Review inspection logs.	
60			Were inspections documented with sufficient in depth and detail to determine type of damage observed.	
61		Critical electrical or imbedded systems (lightning down conductors) shall be checked for proper function periodically	Is the LPS system resistance monitored through the test program? Are the measurements/results reasonable?	
12. Reporting				
62		12.2 The test reports shall contain the following information:	Review if the report(s) meets the reporting requirements. Report(s) should clearly document what tests were performed and provide sufficient information to enable recreate the test or an accurate simulation of the test conditions applied to the blade.	
63		<ul style="list-style-type: none"> • Table of contents 		
64		<ul style="list-style-type: none"> • Contractor for the test 		

Item nr	category	requirement	question	finding
65		<ul style="list-style-type: none"> Dates and locations for the tests 		
66		<ul style="list-style-type: none"> Blade identification 		
67		<ul style="list-style-type: none"> Blade description 		
68		<ul style="list-style-type: none"> Test set-up and procedures 	<p>Are any unique coordinate systems described?</p> <p>Is any non-standard nomenclature or abbreviations described?</p>	
69		<ul style="list-style-type: none"> Description of test load 		
70		<ul style="list-style-type: none"> Test equipment used (including make, model, serial number, etc.) 		
71		<ul style="list-style-type: none"> Reference to calibration records of measurement equipment 		
72		<ul style="list-style-type: none"> Locations of sensors and measurement points 		
73		<ul style="list-style-type: none"> Blade specific calibration details (tare loads, strains, etc.) 		
74		<ul style="list-style-type: none"> Estimated uncertainties 	<p>Are uncertainty estimates given for each result? Are methods used for the estimation reasonable.</p>	
75		<ul style="list-style-type: none"> Description of inspections, repairs, and observations 	<p>Was any damage noted and if so documented sufficiently to determine type and extent of observation and when in the testing process it occurred?</p>	

Item nr	category	requirement	question	finding
			Was the blade altered in any way after it reached the lab and if so noted in the report?	
76		<ul style="list-style-type: none"> Summary of tests and test results 	Should include test type, environmental conditions, loads applied and results.	
77		<ul style="list-style-type: none"> Deviations from test plans, laboratory procedures or normative references 		
78		<ul style="list-style-type: none"> List of references (test plans, laboratory procedures, and normative references). 		
79		12.3 Evaluation of test in relation to design requirements		
80		<ul style="list-style-type: none"> Evaluation of the test loads including test load distribution 	<p>Is the load distribution applied to the blade evaluated accurately considering large deformations (static)? Evaluation of fatigue loading applied (moment distribution and damage equivalent load)?</p> <p>Are the uncertainty in these measurements estimated and reported?</p>	

Item nr	category	requirement	question	finding
81		<ul style="list-style-type: none"><li data-bbox="434 284 824 435">• Evaluation of the test results with respect to the basis for design (the test target loads are typically used for reference).	Are comparisons to the test target loads provided?	
82		<ul style="list-style-type: none"><li data-bbox="434 459 786 513">• Evaluation of the blade stiffness		

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